(12) UK Patent Application (19) GB (11) 2 382 790 (13) A

(43) Date of A Publication 11.06.2003

(21) Application No 0130776.8

(22) Date of Filing 21.12.2001

(30) Priority Data
(31) 0123900.3 (32) 04.10.2001 (33) GB

(71) Applicant(s)
Steven Caffall Finch
35 Greenhurst Road, West Norwood,
LONDON, SE27 0LH, United Kingdom

(72) Inventor(s)
Steven Caffall Finch

(74) Agent and/or Address for Service
Steven Caffall Finch
35 Greenhurst Road, West Norwood,
LONDON, SE27 0LH, United Kingdom

(51) INT CL[7]
B25B 27/18

(52) UK CL (Edition V)
B3N N3B

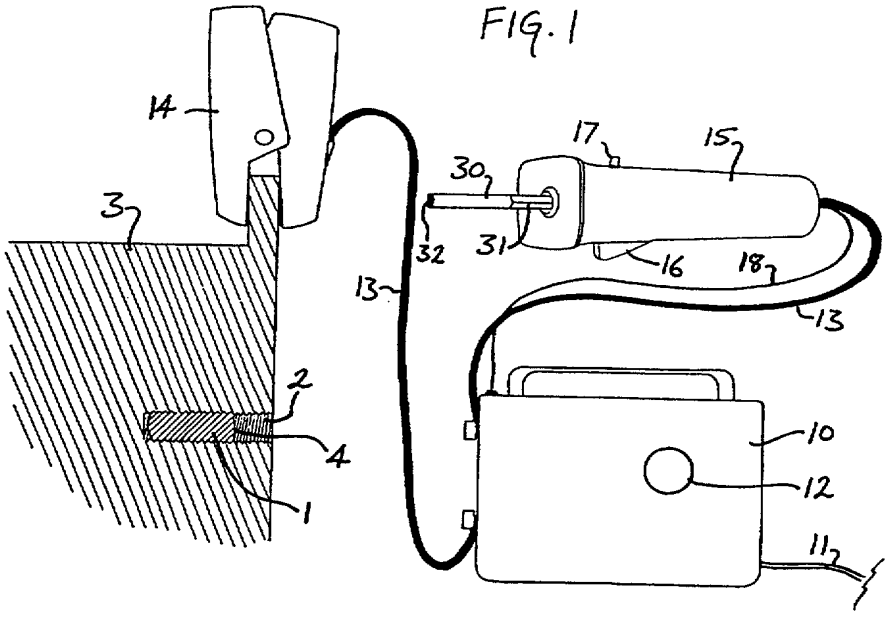
(56) Documents Cited
US 5125144 A US 4138909 A

(58) Field of Search
UK CL (Edition T) B3N N3B
INT CL[7] B25B 27/18
Other: Online databases: Derwent World Patents Index, Patent Abstracts of Japan and European Patent Office

(54) Abstract Title
Method and apparatus for extracting an object from a workpiece

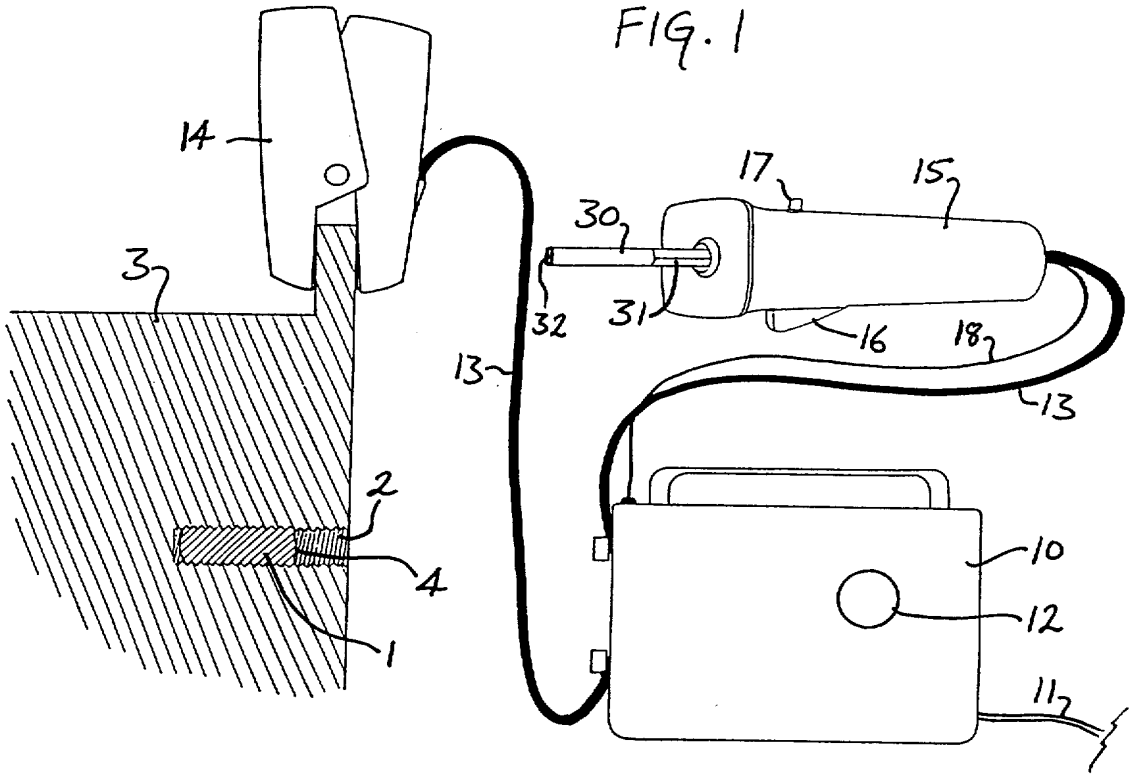
(57) An object such a a broken bolt or tap 1 is extracted from a threaded hole 2 by welding a torque transmitting element 30 to it and then rotating the torque transmitting element. The torque transmitting element includes at least one electrode, and an electric current is passed through the electrode and between the electrode and the object so as to weld the electrode to the object. An apparatus for carrying out the method comprises a hand held tool 15 containing a transformer and an impact driver. A protruding sleeve carries two replaceable electrodes, and in use the sleeve is inserted into the hole containing the object so that the electrodes are pressed against the exposed end of the object. The transformer is actuated, welding the electrodes to the object. The driver then rotates the sleeve, so unscrewing the object.

FIG. 1



GB 2 382 790 A

FIG. 1



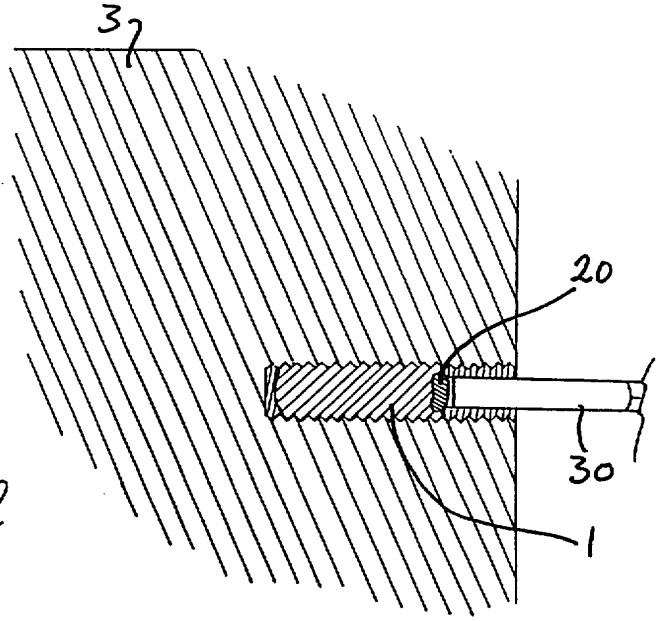


FIG. 2

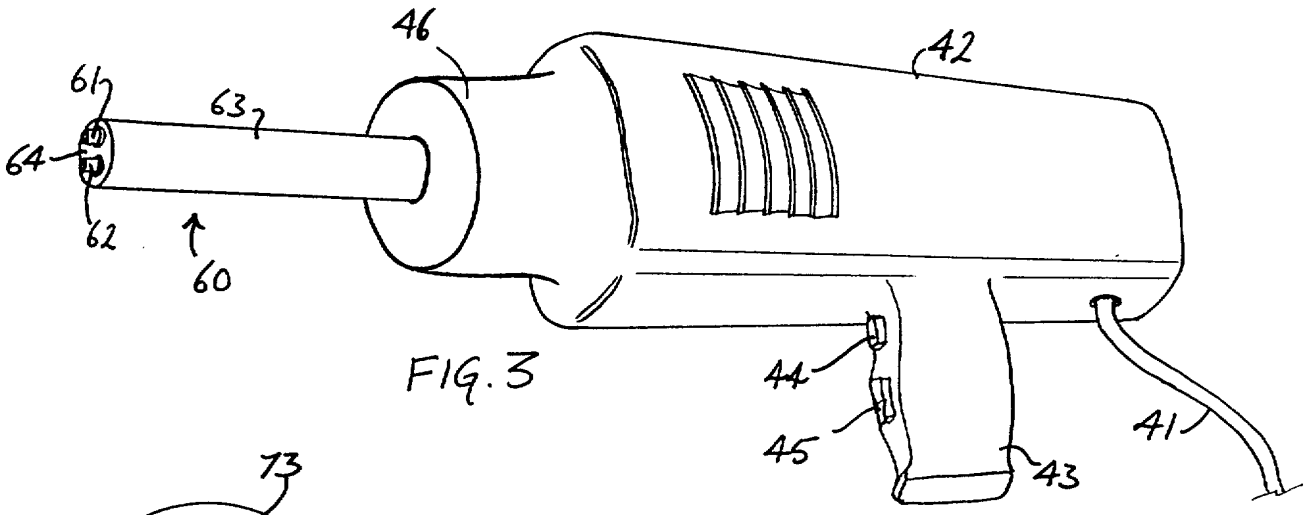


FIG. 3

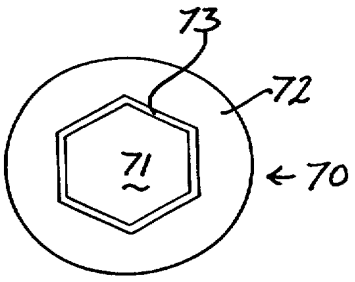


FIG. 6

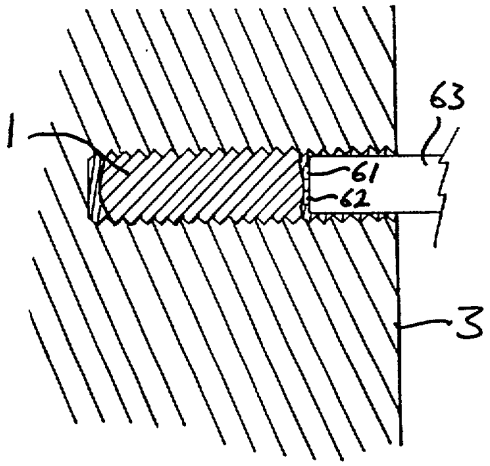


FIG. 4

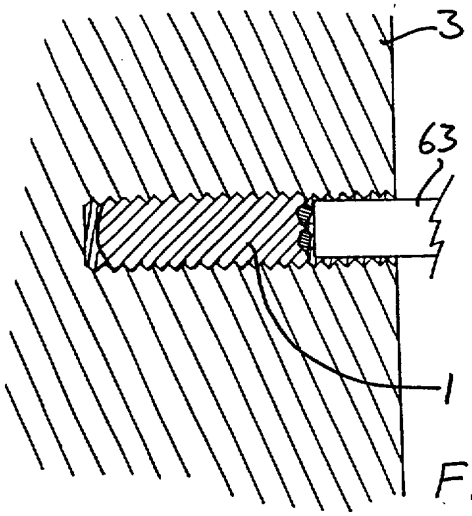


FIG. 5

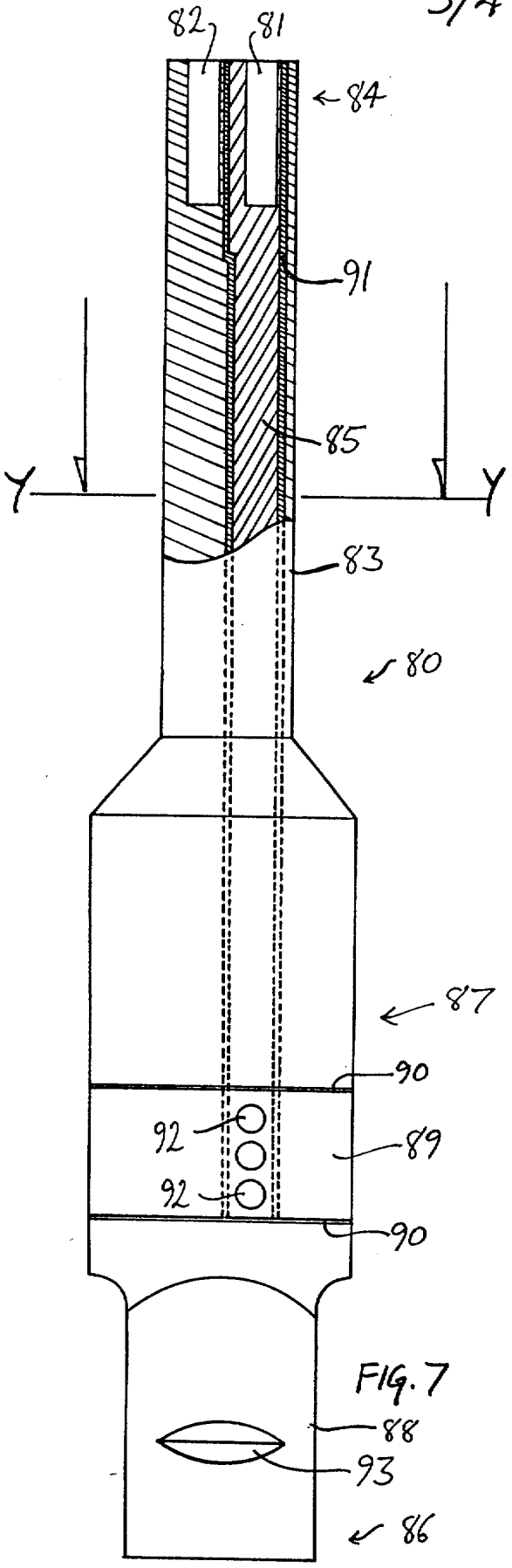


FIG. 7

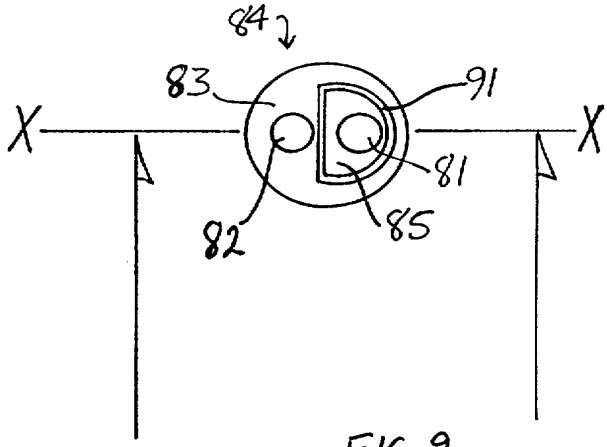


FIG. 9

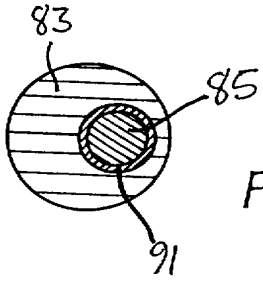


FIG. 10

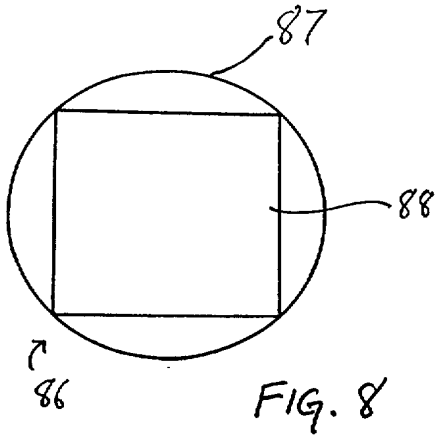


FIG. 8

FIG. 11

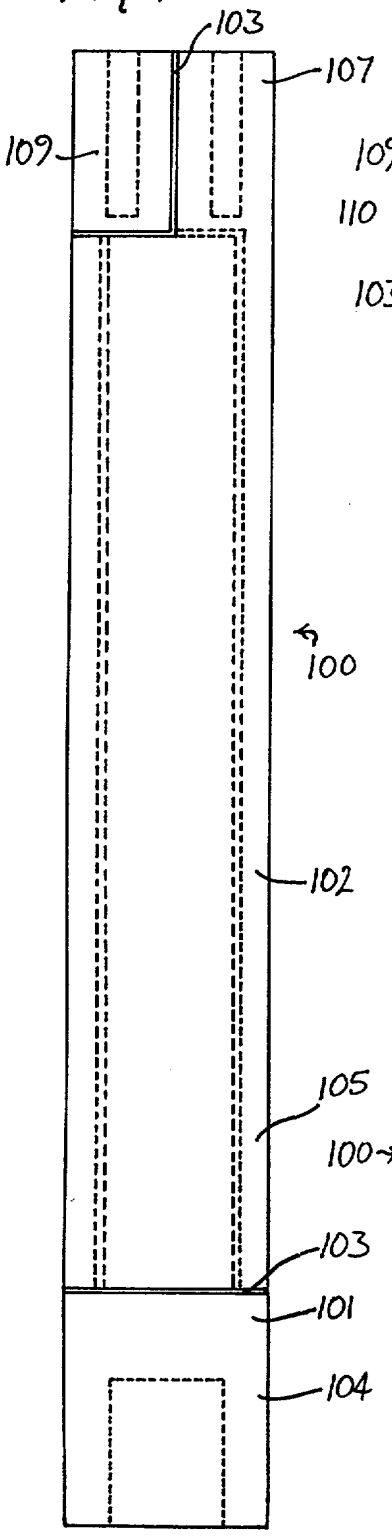
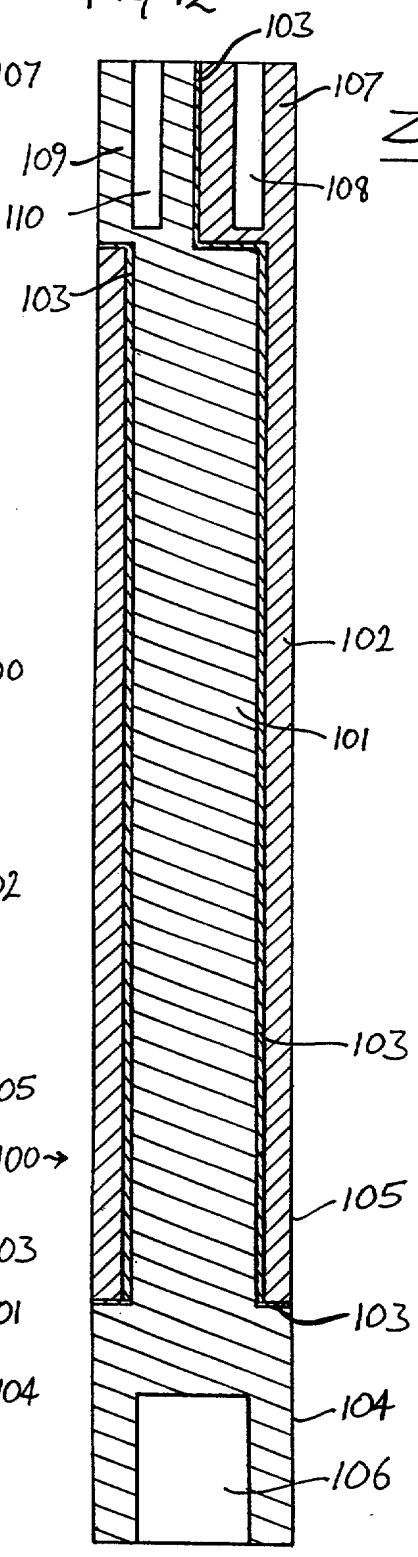


FIG. 12



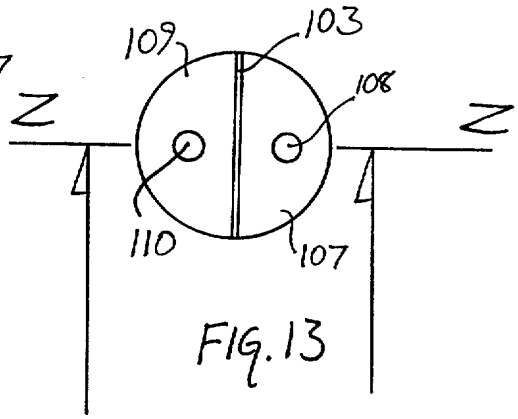
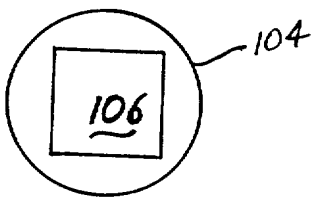


FIG. 13

FIG. 14



Method and apparatus for extracting an object from a workpiece

This invention relates to tools and methods for extracting threaded objects, such as damaged fasteners or tools, from a hole in a workpiece.

Threaded fasteners such as bolts, studs, machine screws and the like frequently become damaged in use. Sometimes the head of the fastener becomes deformed, making it difficult to grip with conventional tools. Sometimes the shaft may break, leaving part of the fastener embedded in a threaded hole in a workpiece such as an engine block.

Tools such as thread cutting taps may also break in service, leaving part of the tap stuck in the hole.

Where the object projects slightly above the surface of the workpiece, the exposed end of the object may be difficult to grip. In many cases the object is left below the surface of the workpiece with only a flat end surface of the object exposed to view. This makes it particularly difficult to extract the embedded object with conventional tools.

A similar problem is encountered when removing security fasteners whose heads have designedly sheared off during installation, leaving only a flat end surface exposed.

Many attempts have been made to solve this problem. Often it is proposed to bore a hole in the exposed end of the object; for example, **WO 94/16862** discloses a tool having a drilling portion at one end and a hole-engaging portion at the other. The tool is first used to drill a hole in the object, then reversed and inserted into the hole. When the tool is turned anticlockwise, left-hand threads on the engaging portion engage in the hole in the object, allowing the object to be rotated and removed.

However, many fasteners and tools are made from very hard steel and may be of small diameter. It is then difficult to drill a hole into the object or to gain a purchase on the walls of the hole so produced. Where the object is embedded in a workpiece of softer material, the hardness of the object may cause the drill to wander off course and damage the workpiece.

Alternative methods have therefore been proposed. **JP 7136940** discloses a cylindrical torque transmitting member. This is inserted into a hole in a workpiece containing a broken bolt until it touches the end of the bolt. An arc welding rod is then inserted into the member, which has a flared shape to guide the tip of the rod to the end of the bolt, and the member is arc welded to the end of the bolt. The member can then be rotated with a spanner to remove the bolt.

However, where an arc welding rod is used in a confined space, the user may be unable to exercise any control over the angle of the rod. This may cause the arc to form either on the walls or on the base of the hole, rather than evenly along the joint between them. This may damage the object or the workpiece, and together with the build up of slag in the hole may prevent the formation of a satisfactory weld. It may also be difficult to provide a cylindrical member of adequate wall thickness to transmit torque to the fastener, whilst providing a sufficiently large bore to admit the welding rod. It is therefore particularly difficult to use this technique to extract fasteners of small diameter.

JP 1127282 discloses a steel plate with a chamfered hole. The plate is placed on the surface of the workpiece over the broken fastener, and welded through the hole. The joint may be strengthened by drilling the fastener before welding, and the plate may incorporate a small tank of water enabling the fastener to be cooled while the workpiece is heated, creating differential expansion. For objects which are embedded below the surface of the workpiece, the plate may include a collar which extends into the hole.

Where this technique is applied to a deeply embedded object, the user may experience difficulty similar to that described above in achieving an adequate weld.

RU 2110042 discloses an alternative method of removing broken threaded tools by means of explosives. A blast proof cap is placed over the hole containing the tool, and an explosive charge is introduced into the hole and detonated. The explosion and tool fragments are confined by the cap.

However, the method may not be practicable for removing an object which is embedded in a hole having only one open end. Furthermore, it may be undesirable or dangerous to employ explosives in a fragile workpiece.

It is therefore the object of the present invention to provide an improved method and apparatus for extracting an object from a workpiece.

According to the present invention there is provided a method of extracting an object from a workpiece, comprising the steps of welding a torque transmitting element to the object, and then applying torque to the torque transmitting element; characterised in that the torque transmitting element includes at least one electrode, and an electric current is passed through the electrode so as to weld the electrode to the object.

According to a further aspect of the present invention there is provided an apparatus for extracting an object from a workpiece, including a torque transmitting element and current generating means; characterised in that the torque transmitting element includes at least one electrode, and the current generating means comprises means for generating an electric current through the electrode so as to weld the electrode to the object.

Various embodiments of the invention will now be described by way of example and with reference to the drawings in which:

Fig. 1 shows a first apparatus for extracting an object from a workpiece, together with an object which is embedded in a workpiece;

Fig. 2 shows an enlarged view of the electrode of the first apparatus welded to the object and ready to remove it;

Fig. 3 shows a second apparatus for extracting an object from a workpiece;

Fig. 4 shows an enlarged view of the torque transmitting element of the second apparatus applied to an embedded object;

Fig. 5 shows the same view as Fig. 4, after welding;

Fig. 6 shows an enlarged end view of an alternative embodiment of the torque transmitting element of the apparatus shown in Fig. 3;

Fig. 7 shows an enlarged view of a torque transmitting element according to a further embodiment of the invention;

Figs. 8 and 9 show end views of the torque transmitting element of Fig. 7;

Fig. 10 shows a cross section through Y – Y of Fig. 7;

Fig. 11 shows an enlarged view of a further torque transmitting element according to a still further embodiment of the invention;

Fig. 12 shows a longitudinal section of Fig. 11 through Z – Z of Fig. 13; and

Figs. 13 and 14 show end views of the torque transmitting element of Fig. 11.

Referring to Fig. 1 a first apparatus is shown for removing an object such as a broken steel bolt 1 from a threaded hole 2 in a cast steel workpiece 3. For clarity the bolt and workpiece are shown throughout in cross section. The apparatus comprises current generating means 10, including a transformer supplied from a mains power supply 11, and having control means and a knob 12 for adjusting the size and duration of the output current. When activated by the user, the current generating means generates a large electric current of a size and duration selected by the user through two large diameter cables 13, which terminate respectively in a clamp 14 and an electrode holder 15. The electrode holder has a releasing lever 16 for securing and passing current to a torque transmitting element 30. A control button 17 on the electrode holder is connected to the current generating means via a control cable 18.

The torque transmitting element 30 comprises a replaceable electrode, which is formed as a steel rod with a square shank 31 which is adapted to be gripped and turned by conventional tools. The tip 32 of the torque transmitting element may be plain, but is shown here as being tapered to an edge so as to present a smaller cross-sectional area, assisting the welding process. The size and shape of the tip 32, and the size of the current, are selected so as to contact the exposed end surface 4 of the bolt 1 over a sufficiently wide area to ensure that the weld can effectively transmit torque to the bolt without shearing off. Alternatively the tip 32 may be formed with two or more projecting points, so as to contact the bolt surface 4 at two or more spaced-apart locations close to its outer periphery, again minimising the danger of the weld shearing off when torque is applied.

In use the clamp is applied to the workpiece so as to form a good electrical contact. A torque transmitting element 30 of suitable size is then inserted into the hole 2, and the user applies force to the electrode holder 15 so that the tip 32 of the torque transmitting element presses against the exposed end surface 4 of the bolt 1. The cross sectional area of the tip of the electrode will determine the amount of force between the tip and the object during welding. The user then presses the control button 17, causing the current generating means 10 to briefly

generate a large current which flows through the circuit comprising the cables 13, clamp 14, torque transmitting element 30, bolt 1 and workpiece 3. The current flows through the electrode 30 and between the tip 32 of the electrode 30 and the surface 4 of the bolt 1.

Referring also to Fig. 2, the torque transmitting element 30 is selected so that the electrical resistance between the limited cross-sectional area of the tip 32 and the bolt surface 4 is greater than the resistance of any other part of the circuit, and in particular is greater than the resistance between the bolt 4 and the workpiece 3. Due to the electrical resistance between the tip 32 of the torque transmitting element and the surface 4 of the bolt, heat is created at this point. The user selects the size and duration of the current by means of the knob 12 so that the heat created is sufficient to momentarily melt the electrode tip 32 and the surface 4 of the bolt, welding them together. The heat then rapidly dissipates, leaving a weld 20 between the torque transmitting element 30 and the bolt 1 (Fig. 2).

After welding, the user removes the electrode holder 15 from the torque transmitting element, by means of the releasing lever 16. Torque may then be applied to the torque transmitting element by engaging the shank 31 with conventional tools, enabling the object 1 to be rotated and so extracted from the workpiece 3.

Because the torque transmitting element 30 is itself an electrode, it may be welded easily and quickly to a deeply embedded object, even where the hole is little larger than the diameter of the torque transmitting element. Since the torque transmitting element may occupy the full diameter of the hole, its strength and torque transmitting capacity are maximised.

Furthermore, the perpendicular orientation of the torque transmitting element 30 with respect to the surface 4 of the object is ideal. In use, the end 32 of the torque transmitting element is merely pressed against the surface 4 of the object 1. The electric current is then passed through the electrode 30 and flows

between the electrode 30 and the object 1, welding them together. Furthermore, the present invention is not dependent on the skill of the operator, and is fast and simple to use. The method is also unaffected by the orientation of the workpiece.

The welding process is similar to spot welding or resistance welding in that the current flows through and between the parts to be welded, and the magnitude of the current used is selected according to the cross-sectional area of the tip of the electrode.

Referring to Fig. 3 a second apparatus is formed as a self contained electric tool supplied by a mains power cable 41. The tool has an outer casing or housing 42 with a handle 43, and a torque transmitting element 60 protrudes from the housing. The casing contains current generating means, including a transformer and means for controlling the magnitude and duration of the current, together with rotation means such as an electric motor or impact driver for rotating the torque transmitting element.

The torque transmitting element 60 comprises two replaceable electrodes 61, 62, and a supporting steel sleeve 63 which rotates with respect to the casing 42. In use, the replaceable electrodes are inserted into longitudinal holes in insulated brass liners located in bores in the end of the sleeve. The liners transfer current to the electrodes, and are supplied with current by conductors within the sleeve. Alternatively, both electrodes may be integrated into a single disposable tip. It is desirable that the electrical contact between the electrodes and the liners extends over as large as possible a surface area of the electrodes, to avoid heating of the electrodes within the sleeve.

Torque is transferred from the motor to the sleeve by coupling means within the casing, and the sleeve supports the electrodes which project from the end 64 of the sleeve by only a small amount. This enables the electrodes 61, 62 to be formed as cheap, replaceable steel rods of relatively small cross section. The electrodes are spaced apart so that they are able to transmit adequate torque to the embedded object, whilst their small cross section assists in the formation of

the weld. The small length of the electrodes which projects beyond the end 64 of the sleeve 63 ensures that adequate torque can be transmitted to the object 1 without bending or breaking the electrodes. Desirably, the sleeve is removable from the housing 42, allowing a selection of sleeves to be provided with the tool. This enables the tool to be used to extract objects of widely different diameters.

The conductors within the sleeve are connected to circumferential conductive bands on the outer surface of the upper part of the sleeve 63 within the casing 42; the conductors and the bands are insulated from the steel sleeve 63. A clamp carrying two conductors is provided within the casing 42, and the clamp is engaged with the conductive bands when the sleeve 63 is stationary in order to transfer the large current required for welding from the transformer to the electrodes.

When the motor is operated to rotate the sleeve 63, the clamp is disengaged to allow the sleeve to rotate. Conveniently the clamp is operated automatically by a solenoid. Alternatively a mechanical connection may be provided so that the clamp is engaged mechanically by the user pressing the switch 44, which operates the current generating means.

Alternatively and more simply, current may be transferred to the torque transmitting element by means of sliding contacts.

Referring to Figs. 7 – 10, in an alternative embodiment, the torque transmitting element 80 is arranged with one electrode in electrical contact with the sleeve 83, and the other in contact with an insulated conductor 85 within the sleeve. Fig. 9 shows the outer end 84, and Fig. 8 the inner end 86 of the torque transmitting element; for clarity the outer end 84 of the torque transmitting element is shown in longitudinal section along line X – X of Fig. 9.

The sleeve 83 may be formed for example from steel, and is integral with a section 87 of larger diameter, on the inner end 86 of which is formed a square shank 88. A bore extends through the sleeve 83 and large diameter section 87

as far as a conductive band 89, which encircles the outer circumference of section 87 and is insulated from it by insulation 90. The conductor 85 is arranged within the bore and insulated by insulation 91. At the end of the bore, the conductor is electrically connected to the conductive band 89 by means of conductive rods or rivets 92 which are pressed into corresponding holes in the conductor and conductive band. Where the rivets 92 pass through the body of the torque transmitting element, they are insulated from it by insulating bushes (not shown). The bushes are arranged in housings formed in the large diameter section 87 of the body of the torque transmitting element, between the conductor 85 and the conductive band 89. The rods or rivets 92 are finished flush and smooth with the outer surface of the band 89.

Advantageously, the bore and conductor are formed with a circular cross section as shown in Fig. 10 for most of their length, simplifying manufacture. At the outer end 84, the bore is widened into a D shape to accommodate the enlarged end of the conductor 85, which is drilled 81 to accept a replaceable electrode. The conductor may be formed for example from copper, and the mass of copper at the outer end 84 is maximised in order to reduce heating of the replaceable electrodes within the sleeve. The other replaceable electrode is inserted in a corresponding hole 82 in the steel sleeve. Alternatively the hole 82 may be formed in a second copper or brass insert, improving the electrical connection between the electrode and the sleeve. The electrodes and the holes 82 may be provided with retaining means for retaining the electrodes therein.

In use, the torque transmitting element is inserted into the body of the tool, as shown in Fig. 3, and the square shank 88 locates in a corresponding socket connected to an impact driver of known type within the tool body. An indentation 93 accepts a spring loaded steel ball which is incorporated in the socket, retaining the shank in place. Alternatively, a square socket or the like may be provided in place of the square shank 88, and the impact driver provided with a corresponding square drive of conventional design.

The current is transmitted to the electrodes by two sliding contacts, or by contacts arranged on disengageable clamp means, arranged to contact respectively the conductive band 89, and the large diameter section 87. Thus the contact which engages the section 87 is connected with the body of the tool and with the electrode inserted into the hole 82, while that engaging the band 89 is connected to the replaceable electrode 81. The section 87 may be provided with a second conductive band to improve its conductivity in the region engaged by the clamp.

Each clamp may comprise one or more copper segments having internal surfaces shaped to correspond with the surfaces of the section 87 and band 89. The segments may be resilient so as to conform closely with the said surfaces, and are preferably articulated, for example by pivoting, so as to move only slightly between the engaged and disengaged positions. Conveniently, the segments are formed as two cooperating shells, each slightly less than a semicircle, and biased apart by a spring. A small solenoid is arranged to force the two shells together when the transformer or equivalent current generating means is energised.

Additional insulation may be arranged around the outside of the sleeve 83 at its outer end 84, to prevent any electrical contact with the workpiece in which the object is embedded. This avoids the possibility of current passing between the object and the workpiece.

One advantage of this embodiment is that the tool body may be formed from largely conventional components, reducing development and manufacturing costs. The socket may be provided on a conventional impact driver, and the current supply provided by a conventional transformer of the type used in portable spot welders. Both the driver and the transformer are housed together in the body of the tool, and current passed from the transformer to the band 89 and large diameter section 87 by means of contacts arranged at the front of the tool, between the socket and the electrodes. Thus in the tool body shown in Fig. 3, the clamps or sliding contacts are arranged in the nose 46.

Alternatively, the impact driver may be integrated into the transformer so that the primary winding and core of the transformer are common to both the transformer and the driver, saving cost and weight.

Preferably a selection of torque transmitting elements 80 is provided, each element having a different sleeve diameter and accepting correspondingly dimensioned electrodes. The elements are easily interchangeable in the tool body, enabling the tool to be applied to fasteners of different diameters.

Referring now to Fig. 11, in a further alternative embodiment the torque transmitting element 100 comprises an inner conductor 101 and an outer conductor 102, together with two replaceable electrodes. The outer conductor is formed as a tube surrounding the inner conductor and separated from it by a layer of insulation 103. The outer conductor terminates short of the inner end 104 of the inner conductor, enabling current to be supplied to the inner conductor via a sliding contact or clamp which in use engages with the inner conductor at its inner end 104. A second sliding contact or clamp engages with the outer conductor at its inner end portion 105. A socket 106 is formed in the inner end 104 of the inner conductor.

At the outer end of the torque transmitting element a D-shaped block 107 is formed integrally with the outer conductor 102, and drilled to provide a hole 108 into which the first replaceable electrode may be inserted. A second D-shaped block 109 is provided at the outer end of the inner conductor 101, and drilled to provide a hole 110 for the second electrode. In use, the torque transmitting element 100 is inserted into the tool body in the same way as described above, the driver being provided with a square driving element which engages the socket 106.

The torque transmitting element may be readily assembled by inserting the inner conductor 101, without the block 109, into the tubular outer conductor 102, together with the insulating layer 103. The block 109 is then bonded to the end of

the inner conductor 101. This may be achieved for example by brazing, in which case the insulation 103 must of course withstand the heat created by the brazing operation. Advantageously, one or more projections are formed at the end of the inner conductor 101, engaging with corresponding cavities formed in the block 109 to enhance the mechanical strength of the brazed joint.

A strengthening collar (not shown) with an insulated lining may be pressed around the blocks 107 and 109 after assembly, helping to retain them together in use. A reduced diameter portion may be formed at the outer end of the torque transmitting element to receive this collar without increasing the overall diameter thereof.

Returning now to Fig. 3, in a further alternative embodiment, the conductors within the sleeve 63 are arranged to project into the casing 42 where they form part of the transformer. This obviates the need to transfer the large current required for welding through a disengageable connection. The transformer is arranged as a primary winding with many turns, and the conductors are arranged within the magnetic flux of the primary winding and electrically connected together at their inner ends to form a single U-shaped conductor. When the electrodes are applied to the surface 4 of the object 1 as described below, the electrodes together with the object 1 and the conductors together form a single turn which acts as the secondary winding of the transformer, and a large current is induced directly in this single turn by the primary winding. An elongate opening may be formed at the inner end of the torque transmitting element, and the conductors arranged to surround the opening. The transformer may be provided with a moveable core, which is inserted through the opening when welding, and retracted to allow the sleeve to be rotated.

Referring now to Figs. 3 - 5, in use the torque transmitting element 60 is pressed against the object 1 which is to be removed from the workpiece 3 so that the electrodes 61, 62 are forced against the exposed end surface of the object. The user then presses the switch 44 which operates the transformer and induces a current of predetermined magnitude and duration in the electrodes 61, 62.

The current flows through each electrode, between each electrode and the object 1, and through the object 1 between the electrodes, the object completing the circuit together with the electrodes. This arrangement is advantageous in that the current does not flow between the object 1 and the workpiece 3. Where the object 1 makes good electrical contact with the workpiece, the first apparatus may be used. However, where the object makes poor contact with the workpiece, the circuit produced by the first apparatus may cause a weld to form at the point where the current passes between the object and the workpiece. For this reason an arrangement with more than one electrode, exemplified by the second apparatus, may be preferred.

The size of the electrodes and the shape of their tips are selected so as to offer the correct cross-sectional area to facilitate welding, as described above with reference to the first apparatus. The size and duration of the current may also be adjustable by the user. The areas between each electrode and the surface of the object therefore form points of high resistance, and the current heats the tips of the electrodes and the surface of the object at these points and welds them together (Fig. 5).

After welding has taken place, which will occur very rapidly, the user releases switch 44 and presses switch 45 which activates the motor or impact driver. The electrical clamp is then disengaged and the motor or driver applies torque to the force transmitting element 60 to unscrew the object 1 from the workpiece 3. The object is thus gripped and unscrewed rapidly and easily in two sequential operations of welding and rotation, without requiring the user to change tools.

When the object is withdrawn, the electrodes may be pulled out of the liners and discarded.

Referring to Fig. 6, in a further alternative embodiment the torque transmitting element 70 may be configured as an elongate inner electrode 71 arranged within an elongate outer electrode 72, obviating the need for a supporting sleeve. A

square shank is formed at the inner end of the outer electrode 72. The inner electrode is preferably of non-circular cross-section to prevent it from rotating within the outer electrode, and electrical insulation 73 is provided between the electrodes. After use, the electrodes may be cut off the object, for example by means of a grinder, and reused. Alternatively they may be removed from the housing and replaced with new electrodes.

The current need not be supplied by a transformer, but may be provided by equivalent electronic means. The abovedescribed embodiments are provided for illustrative purposes only, and many other uses and embodiments of the invention will become apparent to those skilled in the art upon studying the description and drawings.

CLAIMS

1. A method of extracting an object from a workpiece, comprising the steps of welding a torque transmitting element to the object, and then applying torque to the torque transmitting element;

characterised in that the torque transmitting element includes at least one electrode,

and an electric current is passed through the electrode so as to weld the electrode to the object.

2. A method according to claim 1, characterised in that the torque transmitting element includes two electrodes,

and the electric current is passed between each of the two electrodes and the object, so as to weld the torque transmitting element to the object.

3. An apparatus for extracting an object from a workpiece, including a torque transmitting element and current generating means;

characterised in that the torque transmitting element includes at least one electrode,

and the current generating means comprises means for generating an electric current through the electrode

so as to weld the electrode to the object.

4. An apparatus according to claim 3, characterised in that the torque transmitting element comprises two electrodes together with a supporting sleeve,

the electrodes being supported by the sleeve.

5. An apparatus according to claim 4, characterised in that the electrodes may be removed from the sleeve and replaced with new electrodes.

6. An apparatus according to claim 3, characterised in that the torque transmitting element comprises an elongate inner electrode and an elongate outer electrode,

the inner electrode being arranged within the outer electrode,

together with electrical insulation means arranged between the electrodes.

7. An apparatus according to any of claims 3 – 6, characterised in that there is further provided rotation means for rotating the torque transmitting element,

together with means for transferring torque from the rotation means to the torque transmitting element.

8. An apparatus according to claim 7, characterised in that there is further provided a housing, the housing including handle means,

the rotation means and the current generating means being arranged together within the housing,

and the torque transmitting element protruding from the housing.

9. An apparatus according to either of claims 7 or 8, characterised in that there is further provided a clamp for transferring electric current from the current generating means to the torque transmitting element,

together with means for engaging the clamp with the torque transmitting element when the torque transmitting element is welded to the object,

and disengaging the clamp from the torque transmitting element when the torque transmitting element is rotated.

10. An apparatus according to any of claims 3 – 8, characterised in that the current generating means includes a transformer

and the transformer includes at least part of the torque transmitting element,

such that the transformer induces the electric current directly in the torque transmitting element.

11. An apparatus substantially as described herein with reference to the accompanying description and drawings.

Application No: GB 0130776.8
Claims searched: 1 to 11

Examiner: Karl Whitfield
Date of search: 13 August 2002

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.T): B3N (N3B)

Int Cl (Ed.7): B25B 27/18

Other: Online databases: Derwent World Patents Index, Patent Abstracts of Japan and European Patent Office

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	US 5125144	(CLARK) especially figs 1 & 2	1 & 3
X	US 4138909	(JOHNSON) especially fig	1 & 3

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

PUB-NO: GB002382790A
DOCUMENT-IDENTIFIER: GB 2382790 A
TITLE: Method and apparatus for extracting an object from a workpiece
PUBN-DATE: June 11, 2003

INVENTOR-INFORMATION:

NAME	COUNTRY
FINCH, STEVEN CAFFALL	GB

ASSIGNEE-INFORMATION:

NAME	COUNTRY
FINCH STEVEN CAFFALL	GB

APPL-NO: GB00130776
APPL-DATE: December 21, 2001

PRIORITY-DATA: GB00123900A (October 4, 2001)

INT-CL (IPC): B25B027/18

EUR-CL (EPC): B25B027/18